Original Articles.

THE PROTECTIVE POWER OF VACCINATION.[1]

BY JOHN H. McCOLLOM, M.D., OF BOSTON.

WHEN, in the latter part of the last century, Jenner's attention was called to the fact that milkmaids and others who had the care of cows, although exposed to small-pox, had extremely mild attacks of the disease, England was passing through one of the most frightful epidemics of variola that the country has ever experienced. So dire was the havoc, so great was the distress caused by this disease in the middle and latter part of the last century, that anything that would have mitigated its severity would have been hailed as one of the greatest boons to mankind. In the present century epidemics of small-pox have been comparatively rare, and their ravages can in no way be compared to those of the epidemics of the last century.

The 14th day of May, 1796, a day memorable in the annals of medical science, is the natal day of vaccination, for it was on this day that vaccine lymph was taken from the hand of Sarah Holmes, a milkmaid, who had been infected from one of her master's cows, and inserted in the arm of James Phipps, a healthy boy eight years of age. He went through the vaccine disease in a regular manner. On the 1st of July following, the crucial test of the protective power of vaccination was made. The boy, who had been vaccinated in May, was inoculated with matter taken immediately from a small-pox pustule. He did not contract variola.

On December 8, 1802, the Board of Health of Boston published a report of the investigations of eleven of the most distinguished physicians of that time on the protective power of vaccination. The report commences with the following paragraph:

The Board of Health for the town of *Boston*, are happy to have it in their power, this day, to announce to their fellow-citizens the result of one of the most complete experiments which perhaps has ever been made, to prove the efficacy of the *Cow-pox*, as a preventive against the *Small-pox;* and while they take the liberty to congratulate the public on this important discovery, they do earnestly recommend its introduction generally, and are confident that it will be the means of preserving the lives and adding to the happiness of millions.

The report then gives in detail the arrangements that were made to prevent any mistake in the conduct of the experiments, the relation of which need not detain us. The most important part, however, is the report of the physicians themselves, and this is so manifestly important that it will be quoted in full.

THE PHYSICIAN'S REPORT.

With a view of ascertaining the efficacy of the Cow-pox in preventing the Small-pox, and diffusing through this country the knowledge of such facts as might be established by a course of experiments instituted for the purpose, and thereby removing any prejudices, which might possess the public mind on the subject, the Board of Health of the town of *Boston*, in the course of the last Summer, came to a determination to invite a number of Physicians to coöperate with them on this important design; and with a liberality becoming enlightened citizens, erected a Hospital on *Noddle's Island*, for carrying it into execution.— Accordingly, on the 16th day of August last, nineteen boys, whose names are subjoined, were inoculated for the Cow-pox at the office, and in presence of the above mentioned Board, with fresh, transparent Cow-pox matter, taken from the arms of a number of patients then under this disease. These all received and passed through the disease to the complete satisfaction of every one present, conversant with the disease.

On the 9th of November, twelve of the above children, together with one other, GEORGE BARTLETT by name, who had passed through the Cow-pox two years before, were inoculated for the Small-pox on *Noddle's Island*, with matter taken from a Small-pox patient in the most infectious stage of that disease. The arms of these lads became inflamed at the incisions, in proportion to the various irritability of their habits, but not to a degree greater than what any other foreign, virulent matter would have produced. The Small-pox matter excited no general indisposition whatever, through the whole progress of the experiments, though the children took no medicines, but were indulged in their usual modes of living and exercise; and were all lodged promiscuously in one room.

At the same time and place, in order to prove the activity of the Small-pox matter, which had been used, two lads, who had never had either the Small-pox or Cow-pox, were inoculated from the same matter. At the usual time, the arms of these two patients exhibited the true appearance of the Small-pox. A severe eruptive fever ensued, and produced a plenteous crop of Small-pox pustules, amounting by estimation, to more than five hundred in one, and two hundred in the other.

When these pustules were at the highest state of infection, the thirteen children before mentioned, were inoculated a second time, with recent matter, taken from the pustules, which said matter was likewise inserted into the arms of the seven other children, who were absent at the first inoculation. They were all exposed, most of them for twenty days, to infection, by being in the same room with the two boys, who had the Small-pox, so that, if susceptible of this disease, they must inevitably have received it, if not by inoculation, in the natural way.

Each of the children was examined by the Subscribers, who were individually convinced from the inspection of their arms, their perfect state of health, and exemption from every kind of eruption on their bodies, that the Cow-pox prevented their taking the Small-pox, and they do therefore consider the result of the experiment as satisfactory evidence, that the *Cow-pox is a complete security against the Small-pox.*

JAMES LLOYD.	BENJAMIN WATERHOUSE.
SAMUEL DANFORTH.	JOSIAH BARTLETT.
ISAAC RAND.	JOHN FLEET, JUN.
JOHN JEFFRIES.	JOHN C. HOWARD.
JOHN WARREN.	THOMAS DANFORTH.
THOMAS WELSH.	

It must be borne in mind that the men who signed this report had abundant opportunity for observing small-pox, and therefore their testimony regarding the condition of these children after vaccination and after inoculation is of the greatest value.

Having shown that small-pox virus inserted in the arms of vaccinated persons is inert, it may be well to take a glance at mortuary statistics before and after the introduction of vaccination. In Boston, from 1721 to 1792, a period of seventy-one years, there were three very severe and fatal epidemics of small-pox, or one about every twenty-three years. Since 1792 to the present time, a period of over one-hundred years, there has been no serious epidemic of this disease in Boston. The outbreak of small-pox in 1872–73, in this city, bears no comparison in severity to the epidemics of the last century. In this slight epidemic of twenty-one years ago, the ratio of deaths to the thousand of the living was 2.9 in 1872 and in 1873, 1.2, while in the epidemics of the last century from

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one-third to one-fourth of the population succumbed to the disease; or, to put it another way, if the disease had been as prevalent and fatal in 1872–73 as it was in any of the severe epidemics of the last century, the number of deaths would have amounted to 64,300 instead of to 1,040. The investigations of a committee of the Epidemiological Society of London showed conclusively that in England out of every 1.000 deaths in the half century from 1750 to 1800, there were 96 deaths from small-pox, while that out of every 1,000 deaths from 1800 to 1850 inclusive, there were only 35 from this cause; a diminution of nearly two-thirds. In the German States it has been shown that out of every 1,000 deaths before vaccination was employed, 66.5 were caused by small-pox; but that after vaccination came into use there were only 7.26. The report from the British army is very conclusive in favor of the protective power of vaccination, because the regulation regarding vaccination is very strict. Every man is vaccinated at the time of his enlistment. During the Franco-Prussian war, when the French and Prussian armies would alternately occupy the same villages and hamlets, it was found that the French soldiers, who were not carefully vaccinated, suffered from epidemics of small-pox of greater or less severity, while the Prussians, who were very carefully vaccinated, were almost entirely exempt from the disease. In the Prussian army from 1876–1885 inclusive, with an average strength of 300,000 men, there was only one death from small-pox; while in the French army for the same time, with an equal number of men, there was an average of 54 deaths from this disease each year.

The operation of compulsory vaccination was suspended in Zurich, Switzerland, in obedience to popular clamor in 1883. The deaths from small-pox, per 1,000 deaths from all causes for the two previous years and that year had been in 1881, 7; in 1882, 0; in 1883, 8. They rose after compulsion had ceased to be used to 11.45 in 1884; to 52 in 1885; and in 1886 to 85 per 1,000.

The history of the last small-pox epidemic in Montreal illustrates the beneficial effects of vaccination. As is well known, the French residents suffered much more severely than the English, because the latter were comparatively well vaccinated. It was not until the most stringent rules regarding vaccination were adopted that there was any marked abatement in the severity of the epidemic.

The public health records of Sweden show that the average number of deaths in each year from small-pox for one million of the living was from 1774 to 1801, before the introduction of vaccination, 1,973; while during the period of optional vaccination, from 1802 to 1816, the number fell to 479. The most marked diminution was reached, however, during the period of obligatory vaccination, 1817 to 1877, when the average number was only 189 per 1,000,000.

The difference in the number of deaths from small-pox in countries where vaccination is optional, as compared with those where it is compulsory, is very marked. For instance, in Austria-Hungary, in Russia and in France, where vaccination is optional, the death-rate from small-pox per one million of the inhabitants was in 1887 — 583.7; 535.9; 167.0; and in 1888 — 540.3; 231.5; 191.9; respectively. In the German Empire, where vaccination is compulsory, the rate per one million for these two years was in 1887, 1, and in 1888, .8. In Denmark, in Norway and Sweden, where the laws regarding vaccination are very stringent, the death-rate for the corresponding years per 1,000,000, was 0.

It may be of interest to compare the percentage of deaths in the unvaccinated with those of the vaccinated in some of the English Small-pox Hospitals. In the London small-pox hospital, from 1870 to 1872, of 14,808 cases treated, the percentage of deaths in the unvaccinated was 44.8, while of those alleged to have been vaccinated, with or without the evidence of a scar, the percentage was 10.1. In the same hospital from 1876 to 1880, the percentage of deaths in the unvaccinated was 44.4; in the vaccinated, 8.8. In the Homerton Hospital, from February, 1871 to December 31, 1877, during which time 5,479 patients were treated, the percentage of deaths in the unvaccinated was slightly greater than in the London hospital, being 46.1; in the vaccinated there was a corresponding slight increase, the rate being 11.5 per cent. In the Deptford Hospital, in 1881, the percentage of deaths in the unvaccinated was 47.4; in the vaccinated and in those alleged to have been vaccinated, 11.3. In the Fullam Hospital the proportion of deaths of the unvaccinated was 44.2; of the vaccinated, 10.1. In the Dublin Hospital 64.2 per cent. of the unvaccinated died; of the vaccinated, 12.0 per cent. The total number of patients treated in these hospitals was 48,594; the average death-rate of the unvaccinated was 46.9 per cent; of the vaccinated and those alleged to have been vaccinated, 10.35 per cent. The criticism cannot be made with truth that these statistics err on the side of the vaccinated, for, as a matter of fact, they are in favor of the unvaccinated. If only the individuals who had two perfectly characteristic scars of vaccination had been classed among the vaccinated, the percentage of deaths would have been much lower than appears from the figures just mentioned.

In the report of an epidemic of small-pox that occurred in Sheffield, England, in 1887 and 1888, it was found that of 4,493 vaccinated children under ten years of age exposed to the disease, 7.8 per cent. contracted it, and that only one-tenth of one per cent. died; that of 13,435 vaccinated persons of ten years of age and upwards, 28.1 per cent. contracted the disease and 1.4 per cent. died; that of 18,020 vaccinated persons of all ages, exposed to the disease, 23 per cent. contracted it, and the death-rate was 1.1 per cent. On the other hand, of 263 unvaccinated children under ten years of age, 86.9 per cent. had the disease and 38.1 per cent. died; of 469 unvaccinated persons, ten years of age and upwards, 68.6 per cent. had the disease and 37.1 per cent. died; of 736 unvaccinated persons of all ages, 75 per cent. contracted the disease and 37.2 per cent. died. It would seem that these figures ought to convince any one of the protective power of vaccination. Certainly a death-rate of one-tenth of one per cent. in the vaccinated as compared with a death-rate of 38.1 per cent. in the unvaccinated is a most conclusive argument in favor of vaccination.

The statistics of the epidemic in Sheffield also prove the importance of re-vaccination, which is just as necessary as primary vaccination. In every epidemic of variola the small number of the vaccinated who have died have been found, not among those who had recently been vaccinated, but among those who had been vaccinated fifteen to twenty years previous to the outbreak of the disease. This was found to be the case,

in a marked degree, in the epidemic of 1872–73 in Boston. If we look at these Sheffield statistics again we find that the percentage of cases in the vaccinated under ten years of age was 7.8; that the deaths were .1 of one per cent.; while of the vaccinated of ten years of age and upwards the percentage of cases increases to 28.1, and that of the deaths to 1.4. In the class of the vaccinated of all ages, when those under ten years of age become a factor, the cases diminish to 23 per cent. and the deaths to 1.1 per cent. There is no such marked difference in the percentage of deaths among the unvaccinated, although there is a marked increase in the percentage of cases in those under ten years of age as compared with those of ten years and upwards; showing that unvaccinated children are particularly susceptible to the disease. The report of the Registrar-General of England for 1880 shows conclusively that during the period of optional vaccination in that country, from 1847 to 1853, the number of deaths from small-pox in children under five years of age, per 1,000,000 of the inhabitants, was 1,617; while in persons 45 years of age and upwards the number was only 22. In the period of obligatory vaccination, from 1872 to 1880, the number of children under five years of age, per 1,000,000 of the living, who died of the disease, was 323, as compared with 58 in persons of 45 years of age and upwards; showing a marked diminution in the number of deaths in children under five years of age, and a marked increase in the deaths of those of 45 years of age and upwards. These figures embrace both vaccinated and unvaccinated who died of the disease.

It has been claimed that the decline in small-pox mortality is due not to vaccination, but to improved sanitary conditions. If this were true, however, the diminution in other infectious diseases should be as marked as in that of small-pox, which is not the case. While the small-pox death-rate, in England, since the introduction of vaccination, has fallen 80 per cent. in children under five years, that of other diseases has fallen 6 per cent., while the small-pox rate has increased in a marked degree in persons over forty-five years of age, that of other diseases has fallen 3 per cent., or to look at it in another way, while the death-rate from other causes than small-pox, in persons of all ages, has fallen 7 per cent., the death-rate from small-pox has fallen 49 per cent. This marked diminution in the death-rate from small-pox can only be explained by the protective power of vaccination.

In Boston since April, 1881, there have been 217 cases of small-pox. Each patient has been carefully examined in regard to vaccination, and although some of these patients claimed to have been vaccinated, yet, if a satisfactory scar was not found, the patient was classed among the unvaccinated. Of these 217 patients, 121 had been vaccinated, and they all recovered. Of the remaining 96 who did not show any evidence of vaccination, 46 recovered and 50 died, or about 50 per cent. Four of the patients who died stated that they had been vaccinated some twenty-five or thirty years previous to their illness, but as there was no evidence to the fact, as has been before stated, these patients were classed with the unvaccinated. If, however, they had been classed with the vaccinated, the death-rate would still overwhelmingly prove the protective power of vaccination, being 3.2 per cent. in the vaccinated, as compared with 50 per cent. in the unvaccinated.

The influence of a successful vaccination on the course of the eruption of small-pox is very marked. In a case of unmodified small-pox, no matter how mild the attack, the eruption always passes through the regular stages of papule, vesicle and pustule; while in a vaccinated person part of the eruption aborts, that is to say, the papules never become vesicles. If vaccination did nothing more than simply abort the eruption it still would be of inestimable value. When, however, we see vaccinated infants nursing mothers who have small-pox, without the children showing the slightest indication of disease; when we see vaccinated mothers nursing infants ill of the disease, without contracting it, it would seem that any sane man could have no doubt of the protective power of vaccination. The degree of infectiousness of small-pox in the unvaccinated is not fully appreciated. Small-pox is one of the most infectious diseases among the unvaccinated. For instance, during the last winter, in a house containing 25 people, exposed to an unrecognized case of small-pox, 16 of whom were unvaccinated, 14 contracted the disease and five of them died. All of the vaccinated escaped except one man who had been vaccinated 45 years ago, and he had an extremely mild attack of the disease.

The whole matter of protective power of vaccination can be summed up in no better way than by quoting the words of Dr. Russell, health officer of Glasgow, who says:

"After closely observing over 1,000 cases of small-pox in hospital, I have become deeply impressed with the helplessness of medicine when face to face with the unmodified disease. In this sense, the only successful mode of treating small pox is by vaccination. To take firm hold of its efficacy and necessity, and enforce their convictions in practice without wavering, is the most useful, almost the only useful action the medical profession can adopt against variola. When a case presents itself, the first question in prognosis is regarding vaccination, although then the chief work of vaccination has been done, inasmuch as the only other circumstance in the patient's condition which is worth mentioning as affecting the prospects of recovery is the extent of the eruption, which I shall show is the direction in which post-vaccinal small-pox is chiefly modified. If *vaccinated*, then the attitude is one of hope that the disease may be cut short, however bad present appearances are, though, in fact, the probability is that the symptoms are from the first trivial. If *unvaccinated*, then the attack will probably be severe, the eruption copious or confluent, and we recognize a virulence and deep constitutional disturbance against which the resources of medicine are powerless. As regards the individual, the opportunity for medical interference is past, and we can only turn his case to profit by following on those about him the practice from the neglect of which he suffers."

Having proved by statistics from the most reliable sources the great protective power of vaccination, it may be of interest to inquire into the possible dangers and discomforts that may attend or follow the operation. Since the introduction of the use of animal lymph, the danger of inoculating syphilis has been entirely removed. The chance, however, of communicating syphilis by vaccination in the days when humanized lymph was used, almost exclusively, was very slight. There is no well-authenticated and reliable report of such an occurrence in this locality. The

existence of many of the cases reported elsewhere, from careless and inaccurate statements regarding them, must be a matter of doubt to the careful, intelligent and unbiased observer. It has been too much the custom in the report of these cases to completely ignore the possible and probable existence of hereditary or acquired syphilis. If in a given case syphilis appears after vaccination, there should be the most careful and searching investigation in regard to hereditary or acquired disease; but this has not been the case in many instances. It is too much the custom of the laity and, I regret to say it, of some members of the profession, to apply the *post hoc ergo propter hoc* theory to explain the transmission not only of syphilis but of many other diseases by vaccination. Some few years ago a child, who had a slight eruption the nature of which was not evident at the time of the visit, was brought to me for vaccination. On account of this eruption the child was not vaccinated. When he was seen six weeks later he had a perfectly characteristic syphilitic eruption. If this child had been vaccinated no amount of argument would have convinced his parents that the disease was not caused by vaccination. A false keloid tumor may appear at the site of the vaccination, but this has nothing to do with the quality of the lymph used, but is due to some peculiarity of the individual constitution. These false keloids do not cause any pain nor discomfort, but are simply a source of annoyance from their unsightly appearance. These tumors are extremely rare and occur only about once in ten thousand vaccinations. Urticaria is an annoying complication of vaccination, but it is not in the slightest degree a cause for apprehension, and can in no way be attributed to the lymph used. The appearance of this eruption, therefore, cannot with justice be used as an argument against vaccination. The cases of vaccinal urticaria always recover in a short time. They are, however, a source of annoyance to the practitioner and are one of the most fertile sources of argument of the anti-vaccinationist; simply because the anti-vaccinationist is too ignorant of the whole subject of disease to appreciate the relative importance or non-importance of any cutaneous manifestations occurring after vaccination. Six years ago I vaccinated a healthy boy three months old with fresh calf lymph. The vaccine disease went through its regular stages without any undue amount of constitutional disturbance. The vesicles were not especially large. On the eighth day after vaccination the mother of the child, who had never been vaccinated, was vaccinated from her child's arm. She had a perfectly characteristic vesicle, and she also had a very extensive eruption of urticaria. In this case the lymph itself, certainly, was not the cause of the attack of urticaria.

Eczema may possibly be aggravated to a slight extent by vaccination, and when there is no history of any special exposure it is well to postpone vaccination until the eczematous eruption has been relieved by treatment; but after a known exposure or during an epidemic of small-pox there should not be the least hesitation in vaccinating a person suffering from eczema. Dr. Lawson Tait reports in the *British Medical Journal* of 1871 two cases of eczema apparently cured by vaccination. These two cases are not sufficient to prove anything in favor of the curative power of vaccination on eczema, yet they are sufficient to show that vaccination does not always have a distinct injurious effect on this skin disease.

If a child when vaccinated is poorly nourished, and if there is no care taken of the arm, sometimes, by rubbing and scratching after the vaccine vesicle has arrived at maturity, and the retrograde process has commenced, pus organisms may be conveyed from the vaccinated arm to other parts of the body, causing an eruption of impetigo. Impetigo, however, is not a serious disease, and is very easily relieved by proper treatment. The eruption of impetigo has a very slight resemblance to that of small-pox, and this slight similarity has caused ignorant opponents of vaccination to assume that small-pox is caused by vaccination. This argument against vaccination is too absurd to need confutation.

Cellulitis of a somewhat severe type sometimes follows vaccination, but in nearly every instance the attack is due to injury of the vaccine vesicle after it has arrived at maturity. The almost total lack of care of a vaccinated arm is one of the most productive sources of this complication. With proper care on the part of the individual vaccinated, this trouble can almost always be avoided. The glands in the axilla do sometimes suppurate, it is true, and give rise to considerable pain, but this occurrence is so rare, and is so manifestly due to the individual constitution, that it cannot with justice be used to the detriment of vaccination.

Regarding the transmission of tuberculosis by vaccination, there is no proof that this occurrence has ever taken place. Blenheim, it is true, in the *Centralblatt für Bakteriologie* for May 1, 1874, reports a series of experiments in which he states that rabbits inoculated with vaccine lymph from a tuberculous cow, died from tuberculosis, but the number of rabbits used in this experiment is too small, and the period of incubation too short to prove anything. Blenheim, however, makes the wise and pertinent suggestion that all animals before they are used for the propagation of vaccine lymph should be tested with tuberculin. In France, there is a regulation requiring that an autopsy be made on each vaccinated animal before the lymph from it is distributed.

When the specific organism of the vaccine disease is discovered, as some day it surely will be, and that before long, every specious argument against vaccination will be swept away. If the lamented Dr. Stephen C. Martin had not been removed by an untimely death, it is not too much to say that probably pure cultures of the specific organism of vaccinia would now be in use. The advantage of a pure culture of this specific organism is obvious, for instead of propagating the lymph from animal to animal the cultures could be made in a laboratory where every safeguard against contamination could be adopted.

Much has been said regarding deaths due directly or indirectly to vaccination, but the most careful search of the records of deaths in this city, for the past twenty years, fails to show a single instance. The few cases in which vaccination has been alleged to be the cause of death have been, upon investigation, found to be due to some other cause, dependent in no way, either directly or indirectly, on vaccination. One case in which a child was vaccinated and died two weeks afterwards from pneumonia, as proved by the autopsy, is a fair sample of the alleged deaths from vaccination. In another instance a child died from scarlet fever four weeks after being vaccinated, but as the arm was nearly well at the time, the death of the child could

not be attributed to the effect of vaccination. Some few years ago a man about thirty years of age died, five or six weeks after he was vaccinated. There had not been the slightest irritation at the site of the scarification, although it was alleged that he died from the effects of vaccination. The autopsy proved that the man's death was caused by a complication of diseases due in no way to vaccination.

Since April 30, 1873, in this city there have been vaccinated at the public stations nearly 200,000 people, and although there have been some sore arms and a considerable amount of vaccinal uticaria, still there has been no instance of any serious trouble, causing the loss of either life or limb. Careful inquiries at the various hospitals show, that while a certain number of persons have applied for treatment for cutaneous manifestations following vaccination, and for sore arms, there has been no case where there has been any serious trouble.

If the dangers of vaccination were fiftyfold; if its protective power was only one-tenth of what it really is, no man, who has had any experience in the treatment of small-pox, could have any doubt of the value of vaccination to the community. No man who has been brought in daily contact with a person suffering from unmodified small-pox, one of the most repulsive diseases in existence; no man who can intelligently and with an unbiased mind study mortuary statistics, can have any doubt of the protective power of vaccination. This whole subject can be summed up in a few words by the quotation from Scripture placed on Jenner's tomb: "And he stood between the dead and the living; and the plague was stayed."

In no better way can this paper be brought to a close than by quoting Jenner's epitaph, which very concisely embraces the whole subject:

"Within this tomb hath found a resting-place
The great physician of the human race, —
Immortal Jenner! — whose gigantic mind
Brought life and health to more than half mankind.
Let rescued infancy his worth proclaim,
And lisp out blessings on his honored name;
And radiant beauty drop one grateful tear,
For beauty's truest friend lies buried here."

THE ANTERIOR TRANSVERSE ARCH OF THE FOOT: ITS OBLITERATION AS A CAUSE OF METATARSALGIA.[1]

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BY far the most important feature of the human foot, when considered from a mechanical point of view, is the arrangement of the bones of the tarsus and metatarsus into arches, upon which the weight of the body is borne in standing or walking. These arches are arranged longitudinally and transversely, and the proper maintenance of both is important.

The longitudinal or antero-posterior arch is the larger and the more important. Anatomically it is thoroughly understood, its pathological conditions are well recognized, and the methods of treatment are well defined.

The transverse arch is smaller, less noticeable, and of much less importance in the large majority of cases. Anatomically it is recognized; but its pathological conditions have not been considered. It is most noticeable at the tarsus, where it is formed by the cuboid, scaphoid and the three cuneiform bones, but extends forward as far as the metatarso-phalangeal articulations, where, although much less clearly defined, it truly exists. Its presence at this point, a fact which has been denied by some authorities, has been proved to the satisfaction of the writer by the careful study of frozen sections of feet, and of impressions of the feet taken while supporting different degrees of the weight of the body. In the tarsus it is quite rigid, and is obliterated only as the longitudinal arch is obliterated, both being supported at this point by practically the same structures. In the anterior portion of the foot or at the metatarso-phalangeal articulations, it is less marked, and is present only when the foot is at rest or supporting comparatively little weight.

When the foot is first placed upon the floor, the heel and the outer and inner portions of the ball form the points of contact. In this position the heads of the second and third metatarsal bones are in a plane distinctly above the others, and no weight is borne directly upon them. As more weight is added, the ball of the foot is gradually widened and the heads of the second and third metatarsal bones are lowered; these, together with the first metatarsal forming the chief support when all of the weight of the body is thrown upon the foot. At the same time the foot rolls outward: partly owing to a yielding of the antero-posterior arch, which causes a slight lengthening of the foot, and partly owing to the way in which the weight is received upon an arch that is poorly supported on the inner side. In this way the inner side of the foot is brought nearer the floor, and the centre of bearing is moved toward the inner side, thus relieving the outer side from much pressure. When the foot is raised or the weight taken off, the reverse takes place; the foot shortens, owing to the re-forming of the longitudinal arch; the second and third metatarsal bones are raised — or the anterior transverse arch is re-formed; and the heel and the outer and inner portions of the ball of the foot form the last points of contact. From this it is seen that in walking the relations of the structures of the feet are constantly changing; the anterior transverse arch is continually being obliterated and re-formed, the longitudinal arch is alternately lower and higher, while the ligaments which are involved are constantly stretched and relaxed, and the muscles are in the state of alternate rest and contraction.

The anterior transverse arch is formed by the heads of the metatarsal bones; the first and the fourth and fifth (which act together) furnishing the base, while the second and third are raised above this plane, forming, as seen upon cross-section, a low arch. This relation is maintained by the transverse ligament, the transversalis pedis muscle, and the tendons of the peroneous longus and the tibialis posticus muscles. The planta fascia, which is reinforced in its anterior expansion by transverse fibres, and the tendon of the flexor longus digitorum muscles — from its insertion and its oblique course across the sole of the foot — undoubtedly also exert some influence.

After studying a considerable number of cases in which the symptoms were referred to the feet, and after experimenting with various lines of treatment, the author is convinced that the obliteration of this transverse arch is the direct cause of many of the symptoms, and that its restoration in these cases is of the same importance as is that of the longitudinal arch

[1] Read by title at the American Orthopedic Association, Washington, May 30, 1894.